Total Dose Steady-State Irradiation Test Report of Power MOSFETs
*****BUY65CS family*****

Dr. Tudor Chirila	PMM RFS D HIR	
Dietmar Schwertberger	PMM RFS D HIR	
Dr. Bernd Eisener	PMM RFS D HIR	

TABLE OF CONTENTS

TABLE OF CONTENTS **1**
§1 SCOPE **2**
§2 DEVICE INFORMATION **2**
§2.1 APPLICABLE DOCUMENTS 2
§2.2 DEVICES MARKINGS AND SAMPLE PREPARATION 2
§2.3 PRE- AND POST-IRRADIATION ELECTRICAL TESTS 3
§3 IRRADIATION FACILITY JS-9000 ..... **4**
§4 TEST CONDITION AND SEQUENCE **5**
§4.1 ELECTRICAL BIAS DURING IRRADIATION 5
§4.2 RADIATION EXPOSURE AND TEST SEQUENCE 5
§5 TEST RESULTS **5**
§5.1 L5452B – BUY65CS08J 6
§5.2 L5454A – BUY65CS28A 8
§6 SUMMARY AND SAMPLE LIST **9**

Geschützte Daten. Alle Rechte vorbehalten. Proprietary data. All rights reserved.

§1 SCOPE

This Test Report describes Total Dose Steady-State Irradiation (TID) tests and results of radiation-hardened power MOSFETs from Infineon Technologies, types BUY06CS, in accordance to ESCC Basic Specification 22900.

Tests TID47 and TID48 have been performed at the Plant JS-9000 of Synergy Health Allershausen GmbH, Allershausen, Germany on the 26.7.2018 and 20.02.2019.

TID	Location	Date	Facility	Dose Rate	Total Dose (100%)
47	Allershausen	26.07.2018	JS-9000	38.70 krad/h (Note 1)	143.28 krad
48	Allershausen	20.02.2019	JS-9000	31.16 krad/h (Note 1)	95.56 krad

Table 1: Overview of TID Tests for BUY65CS.

Notes:
1. Dose rate performance measured during the test.

§2 DEVICE INFORMATION

Chip type	Part Type	BVdss [V]	Vgs(th) [V]	Rds(on) [mOhm]	Idmax [A]
L5452B	BUY65CS08J	650	2.0 – 4.0	450	8 (RT)
L5454A	BUY65CS28A	650	2.0 – 4.0	150	28 (RT)

Table 2: Overview irradiated chip types and correlation to parts.

§2.1 APPLICABLE DOCUMENTS

- BUY65CS ESCC Draft Detail Specification for HiRel RadHard Power-MOS 650V family, Version June 2019.
- ESCC Basic Specification 22900

§2.2 DEVICES MARKINGS AND SAMPLE PREPARATION

In order to contact devices with the test sockets on bias boards, chips have been soldered and bonded to respective 3-pin PCB-TO-adapter boards to connect Gate/Drain/Source contacts of the MOSFETs.

Devices' numbers are written on the PCB with a permanent marker. The number correlates in the sample list to the lot and wafer number.

Geschützte Daten. Alle Rechte vorbehalten. Proprietary data. All rights reserved.

§2.3 PRE- AND POST-IRRADIATION ELECTRICAL TESTS

Test samples have passed on-wafer tests, notably BVDSS, Vgs(th), RDSON, IDSS, IGSS with their parameters within predetermined upper/lower limits.

The following parameters were measured for test samples of type BUY65CS (see Tab. 2):

- IDSS(520V),
- IGSS(+/-20V),
- RDSON(ID, Ugs=10V)
  L5452B: ID = 5A
  L5454A: ID = 18A
- VSD(ID)
  L5452B: ID = 8A
  L5454A: ID = 28A
- Vgs(th)(1mA),
- BVDSS(0.25mA).

Geschützte Daten. Alle Rechte vorbehalten. Proprietary data. All rights reserved.

§3 IRRADIATION FACILITY JS-9000

The JS-9000 irradiator at Synergy Health Allershausen GmbH is a pallet facility designed to irradiate large volumes of palletized products. The irradiation source is Co60.

For irradiations in this facility the samples are placed in an aluminium-lead container as recommended in ESCC 22900 §4.1.2. The irradiation field in the container has been determined by means of dose mapping. Dose rate varies from 91.4% to 105.7% which is in the +/-10% allowed window. Samples are placed such that the dose rate variation across the field of interest is between 94.2% and 105.7%.

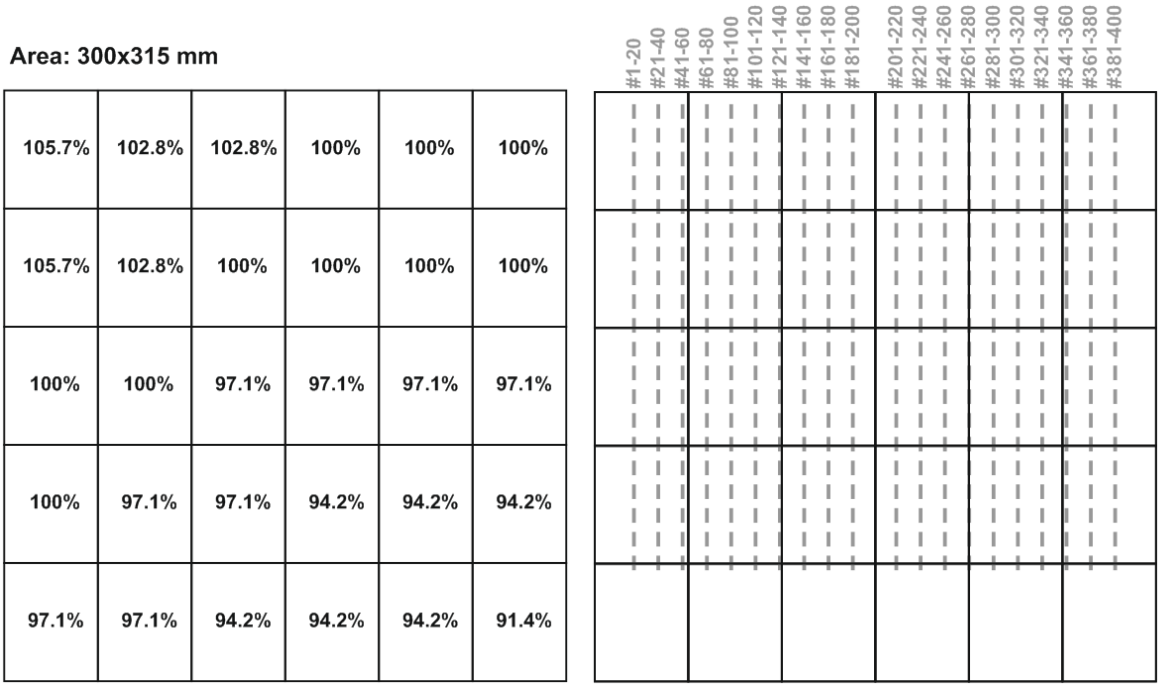


Fig. 2: Left: Gamma intensity within the container. Right: sample positions #1-400 with respect to the characterized irradiation plane.

Geschützte Daten. Alle Rechte vorbehalten. Proprietary data. All rights reserved.

§4 TEST CONDITION AND SEQUENCE

§4.1 ELECTRICAL BIAS DURING IRRADIATION

Condition	VDS(V)	VGS(V)
C1	0	+20
C2	0	-20
C3	650	0
Float	Floating	Floating

Table 3 Electrical bias conditions during irradiation and subsequent annealing.

§4.2 RADIATION EXPOSURE AND TEST SEQUENCE

Irradiation- anneal- and characterization steps according to the FLOW CHART FOR QUALIFICATION TESTING of Basic Specifications ESCC22900.

1. Sample serialization,
2. Electrical pre-test according to §2.3,
3. Irradiation with a dose rate and total dose as specified in Tab. 1, in one irradiation step,
4. Parameter measurements according to §2.3,
5. Room temperature anneal for 24 hours under the same bias as during irradiation, followed by parameter measurements according to §2.3,
6. Accelerated aging under the same bias as during irradiation: 168 hours at 100°C,
7. Electrical post-rad/post anneal test, according to §2.3.

§5 TEST RESULTS

In the following, each of the electrically parameters listed in §2.3 is plotted for four points of the testing sequence, i.e.

1. Prior to irradiation (pre-rad),
2. Post-irradiation (post-rad),
3. Posterior to room-temperature anneal of 24 hours (anneal 24h),
4. Posterior to 168 hours of anneal at 100°C (anneal 168h).

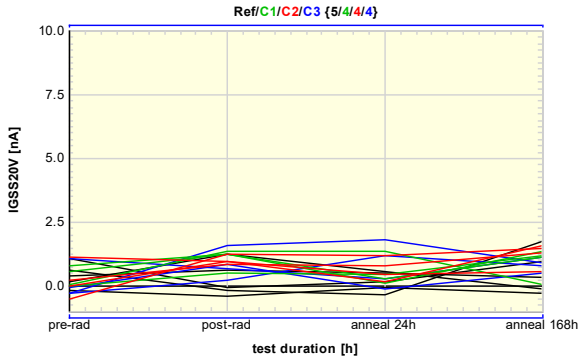
Four groups of graphs are given coded by line-color (see tab. 1 and tab. 2):

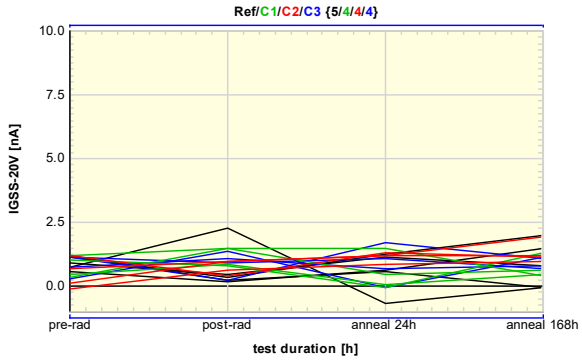
1. Unirradiated control (reference) devices (legend: ***Ref*** in BLACK)
2. Irradiated devices Bias Condition C1 (legend: ***C1*** in GREEN)
3. Irradiated devices Bias Condition C2 (legend: ***C2*** in RED)
4. Irradiated devices Bias Condition C3 or Float (legend: ***C3*** or ***Float*** in BLUE)

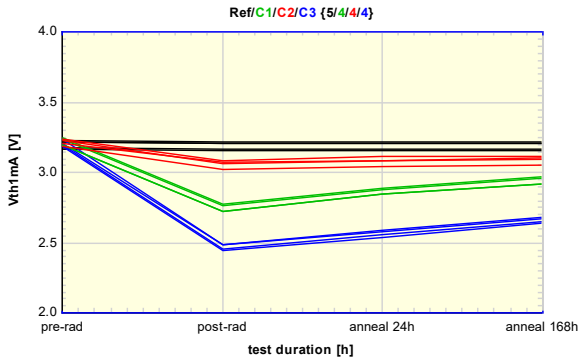
Geschützte Daten. Alle Rechte vorbehalten. Proprietary data. All rights reserved.

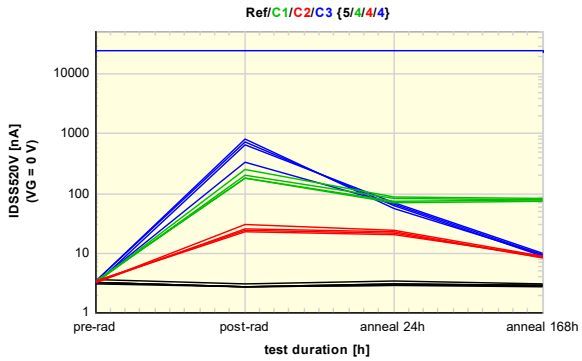
§5.1 L5452B – BUY65CS08J

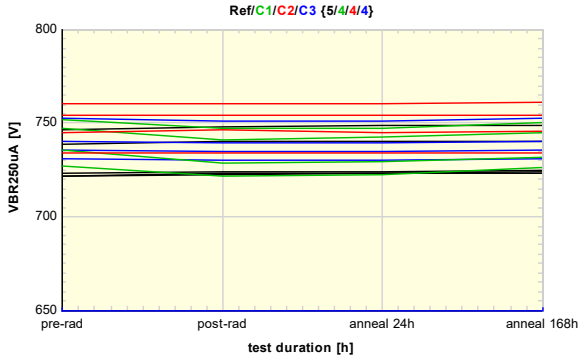
BUY65CS08J / L5452B / TID47

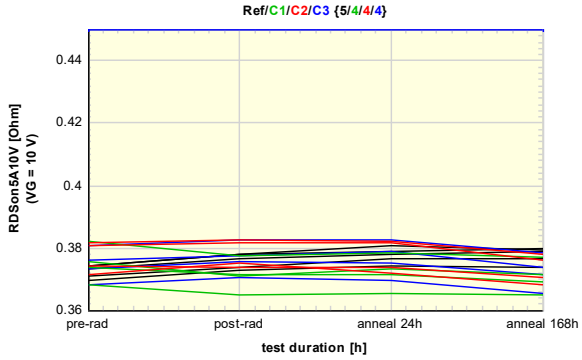


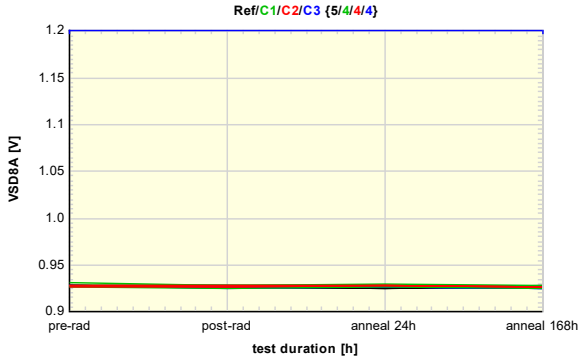






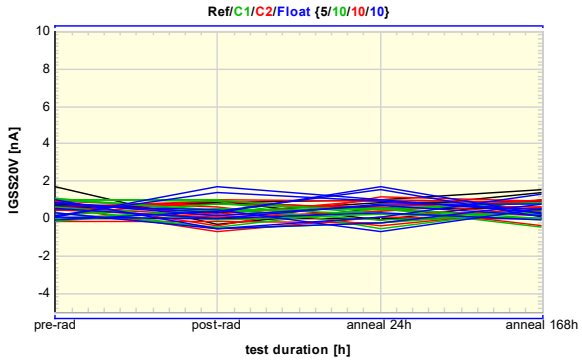


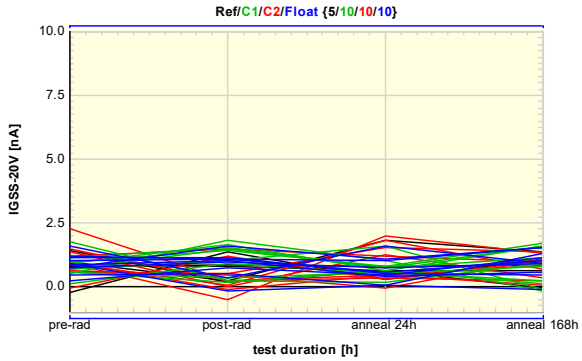


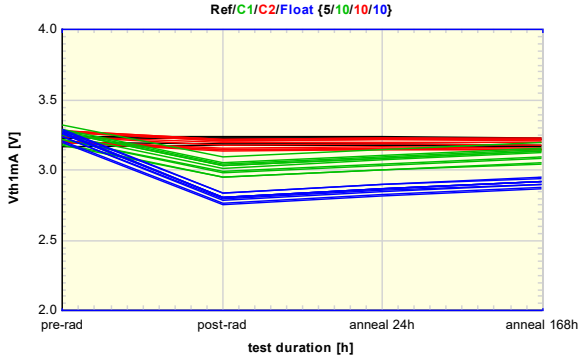


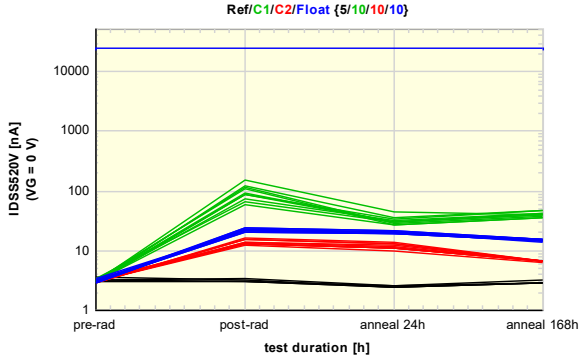
Geschützte Daten. Alle Rechte vorbehalten. Proprietary data. All rights reserved.

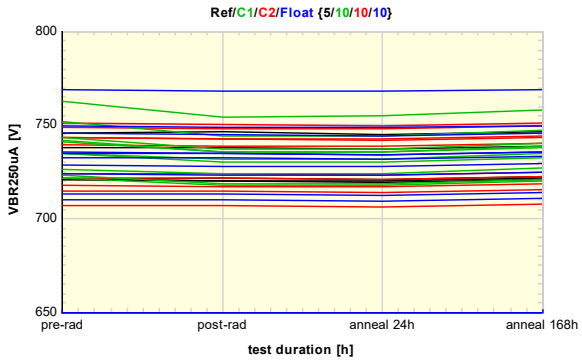
BUY65CS08J / L5452B / TID48

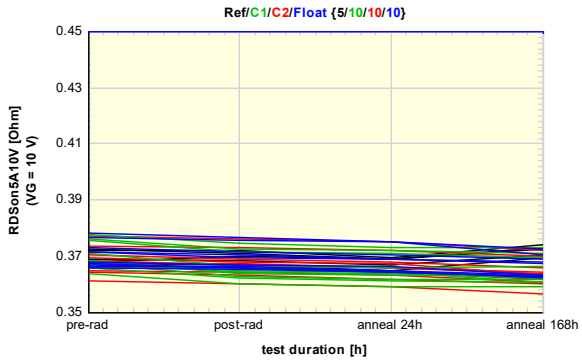


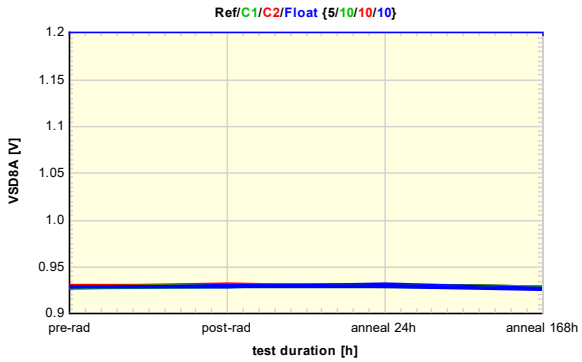








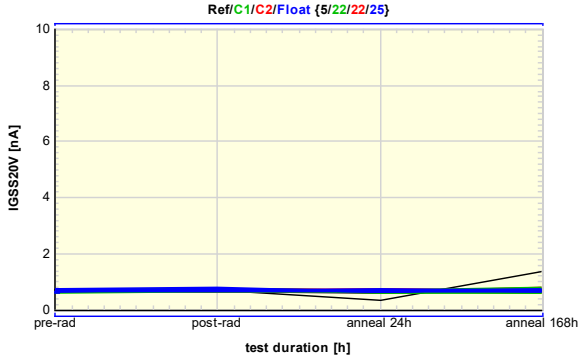


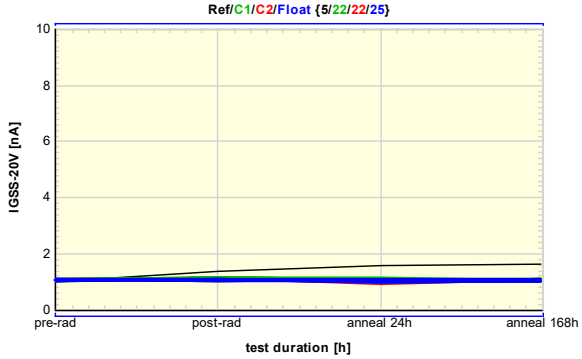


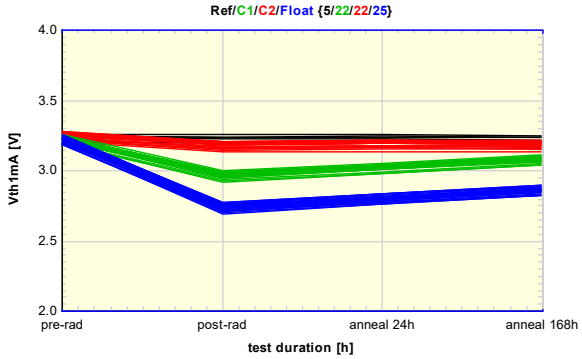
Geschützte Daten. Alle Rechte vorbehalten. Proprietary data. All rights reserved.

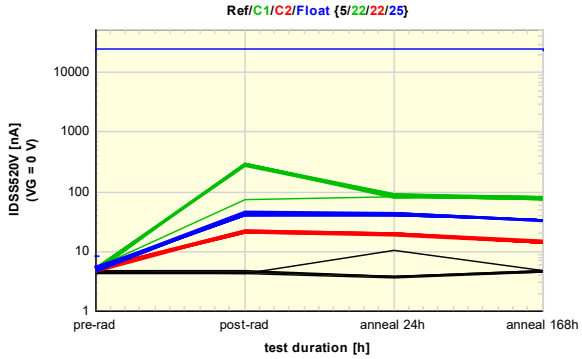
§5.2 L5454A – BUY65CS28A

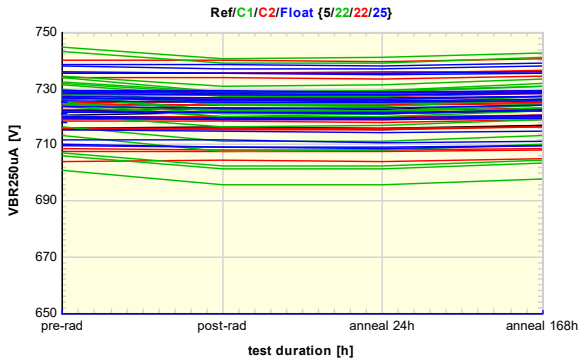
BUY65CS28A / L5454A / TID48

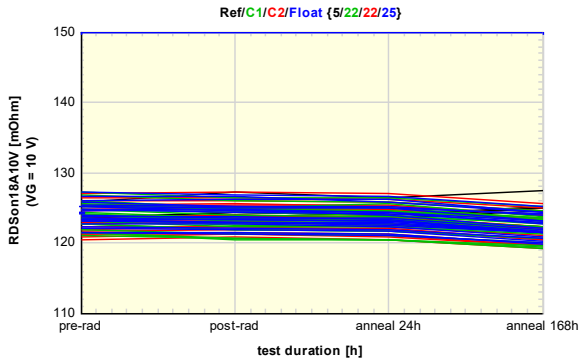


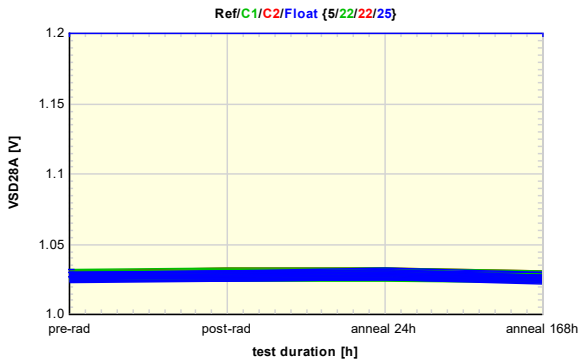












Geschützte Daten. Alle Rechte vorbehalten. Proprietary data. All rights reserved.

§6 SUMMARY AND SAMPLE LIST

This report shows that the BUY65CS family is radiation hard up to a minimum of 100krad and can be classified with a Total Dose Radiation Level – **R**.

TID 47							
SN	**Type**	**Lot**	**Wafer**	**Cond.**	**Level**	**Position**	**Result**
81	BUY65CS08J	VE813036	1	C1		221	pass
82	BUY65CS08J	VE813036	1	C2		261	pass
83	BUY65CS08J	VE813036	1	C3		162	pass
84	BUY65CS08J	VE813036	1	C1		222	pass
85	BUY65CS08J	VE813036	1	C2		262	pass
86	BUY65CS08J	VE813036	1	C3		163	pass
87	BUY65CS08J	VE813036	2	C1		223	pass
88	BUY65CS08J	VE813036	2	C2		263	pass
89	BUY65CS08J	VE813036	2	C3		164	pass
90	BUY65CS08J	VE813036	2	C1		224	pass
91	BUY65CS08J	VE813036	2	C2		264	pass
92	BUY65CS08J	VE813036	2	C3		165	pass
93	BUY65CS08J	VE813036	2				Control
94	BUY65CS08J	VE813036	2				Control
95	BUY65CS08J	VE813036	2				Control
96	BUY65CS08J	VE813036	2				Control
97	BUY65CS08J	VE813036	2				Control
TID 48							
SN	**Type**	**Lot**	**Wafer**	**Cond.**	**Level**	**Position**	**Result**
281	L5454A	VE840444	23	C1		209	pass
282	L5454A	VE840444	23	C2		89	pass
283	L5454A	VE840444	23	Float		281	pass
284	L5454A	VE840444	23	C1		210	pass
285	L5454A	VE840444	23	C2		90	pass
286	L5454A	VE840444	23	Float		282	pass
287	L5454A	VE840444	7	C1		211	pass
288	L5454A	VE840444	7	C2		91	pass
289	L5454A	VE840444	7	Float		283	pass
290	L5454A	VE840444	7	C1		212	pass
291	L5454A	VE840444	7	C2		92	pass
292	L5454A	VE840444	7	Float		284	pass
293	L5454A	VE840444	10	C1		213	pass
294	L5454A	VE840444	10	C2		93	pass
295	L5454A	VE840444	10	Float		285	pass
296	L5454A	VE840444	10	C1		214	pass
297	L5454A	VE840444	10	C2		94	pass
298	L5454A	VE840444	10	Float		286	pass
299	L5454A	VE840444	11	C1		215	pass
300	L5454A	VE840444	11	C2		95	pass
301	L5454A	VE840444	11	Float		287	pass
302	L5454A	VE840444	11	C1		216	pass
303	L5454A	VE840444	11	C2		96	pass
304	L5454A	VE840444	11	Float		288	pass
305	L5454A	VE840444	12	C1		217	pass
306	L5454A	VE840444	12	C2		97	pass
307	L5454A	VE840444	12	Float		289	pass
308	L5454A	VE840444	12	C1		218	pass
309	L5454A	VE840444	12	C2		98	pass
310	L5454A	VE840444	12	Float		290	pass
311	L5454A	VE840444	13	C1		219	pass

Geschützte Daten. Alle Rechte vorbehalten. Proprietary data. All rights reserved.

312	L5454A	VE840444	13	C2		99	pass
313	L5454A	VE840444	13	Float		291	pass
314	L5454A	VE840444	13	C1		220	pass
315	L5454A	VE840444	13	C2		100	pass
316	L5454A	VE840444	13	Float		292	pass
317	L5454A	VE840444	14	C1		221	pass
318	L5454A	VE840444	14	C2		101	pass
319	L5454A	VE840444	14	Float		293	pass
320	L5454A	VE840444	14	C1		222	pass
321	L5454A	VE840444	14	C2		102	pass
322	L5454A	VE840444	14	Float		294	pass
323	L5454A	VE840444	16	C1		223	pass
324	L5454A	VE840444	16	C2		103	pass
325	L5454A	VE840444	16	Float		295	pass
326	L5454A	VE840444	16	C1		224	pass
327	L5454A	VE840444	16	C2		104	pass
328	L5454A	VE840444	16	Float		296	pass
329	L5454A	VE840444	17	C1		225	pass
330	L5454A	VE840444	17	C2		105	pass
331	L5454A	VE840444	17	Float		297	pass
332	L5454A	VE840444	17	C1		226	pass
333	L5454A	VE840444	17	C2		106	pass
334	L5454A	VE840444	17	Float		298	pass
335	L5454A	VE840444	21	C1		227	pass
336	L5454A	VE840444	21	C2		107	pass
337	L5454A	VE840444	21	Float		301	pass
338	L5454A	VE840444	21	C1		228	pass
339	L5454A	VE840444	21	C2		108	pass
340	L5454A	VE840444	21	Float		302	pass
344	L5454A	VE840444	22	C1		229	pass
345	L5454A	VE840444	22	C2		109	pass
346	L5454A	VE840444	22	Float		306	pass
347	L5454A	VE840444	22	C1		230	pass
348	L5454A	VE840444	22	C2		110	pass
349	L5454A	VE840444	22	Float		307	pass
350	L5454A	VE840444	22				Control
351	L5454A	VE840444	22				Control
352	L5454A	VE840444	22				Control
353	L5454A	VE840444	22				Control
354	L5454A	VE840444	22				Control
355	L5452B	VE813036	4	C1		231	pass
356	L5452B	VE813036	4	C2		111	pass
357	L5452B	VE813036	4	Float		308	pass
358	L5452B	VE813036	4	C1		232	pass
359	L5452B	VE813036	4	C2		112	pass
360	L5452B	VE813036	4	Float		309	pass
361	L5452B	VE813036	5	C1		233	pass
362	L5452B	VE813036	5	C2		113	pass
363	L5452B	VE813036	5	Float		310	pass
364	L5452B	VE813036	5	C1		234	pass
365	L5452B	VE813036	5	C2		114	pass
366	L5452B	VE813036	5	Float		311	pass
367	L5452B	VE813036	6	C1		235	pass
368	L5452B	VE813036	6	C2		115	pass
369	L5452B	VE813036	6	Float		312	pass
370	L5452B	VE813036	6	C1		236	pass
371	L5452B	VE813036	6	C2		116	pass
372	L5452B	VE813036	6	Float		313	pass

Geschützte Daten. Alle Rechte vorbehalten.
Proprietary data. All rights reserved.

373	L5452B	VE810011	8	C1		237	pass
374	L5452B	VE810011	8	C2		117	pass
375	L5452B	VE810011	8	Float		314	pass
376	L5452B	VE810011	8	C1		238	pass
377	L5452B	VE810011	8	C2		118	pass
378	L5452B	VE810011	8	Float		315	pass
379	L5452B	VE810011	9	C1		239	pass
380	L5452B	VE810011	9	C2		119	pass
381	L5452B	VE810011	9	Float		316	pass
382	L5452B	VE810011	9	C1		240	pass
383	L5452B	VE810011	9	C2		120	pass
384	L5452B	VE810011	9	Float		317	pass
93	BUY65CS08J	VE813036	2				Control
94	BUY65CS08J	VE813036	2				Control
95	BUY65CS08J	VE813036	2				Control
96	BUY65CS08J	VE813036	2				Control
97	BUY65CS08J	VE813036	2				Control

Table 4: List of irradiated and control devices

Geschützte Daten. Alle Rechte vorbehalten. Proprietary data. All rights reserved.